Exploring the Potential of Beeswax processing by-product in the Food Industry for Environmental Sustainability

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INTRODUCTION

Beeswax is a mixture of hydrocarbons, free fatty acids, esters of fatty acids and fatty alcohols, diesters and other substances produced endogenously by specialised organs in adult bees (Fratini et al., 2016; Peron et al., 2023). This STSM aims to investigate the potential of beeswax by-product residue (BBR), a by-product generated during the processing and purification of beeswax, as a valuable material in the food industry. BBR which often retains residual honey, resins, polyphenols, and other compounds, is still underutilized despite its richness in bioactive compounds. In line with circular economy principles, this study seeks to evaluate the compositional, functional, and technological potential of this underexplored material to promote sustainable food production.

OBJECTIVES

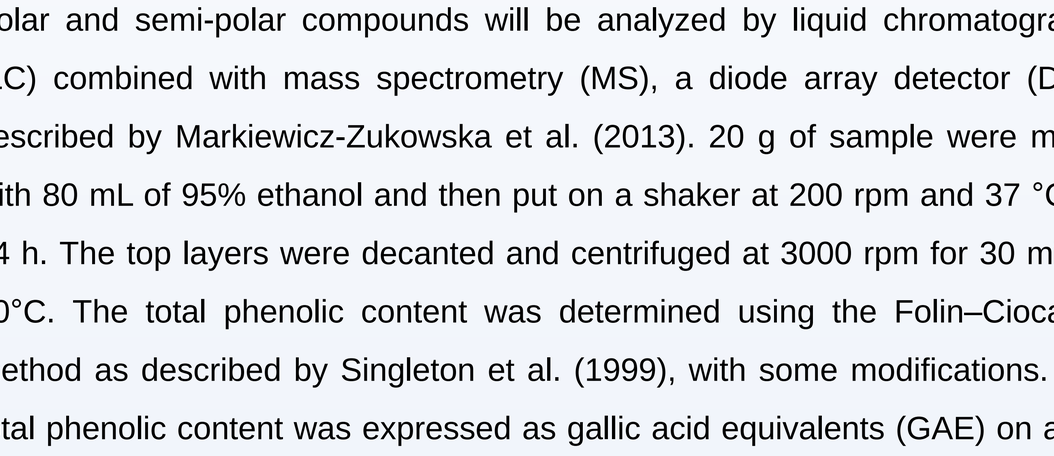
The primary objectives of this study are:

1. To determine the bioactive compound content of BBR– Specifically, to quantify the total phenolic content (TPC) and total flavonoid content (TFC) in BBR samples collected from Bingöl, Türkiye.
2. To evaluate the antioxidant activity of BBR– By applying DPPH and FRAP assays, this study aims to assess the antioxidant potential of BBR and its relevance for functional food applications.

By addressing these objectives, the study aims to contribute to the valorization of BBR, promoting its potential role in functional foods and reducing waste in the beekeeping industry.

MATERIALS & METHODS

BBR samples were collected from beekeepers and/or bee product processing facilities from Bingöl, Türkiye under suitable conditions. The chemical composition of BBR will be investigated using a range of analytical techniques. Polar and semi-polar compounds will be analyzed by liquid chromatography (LC) combined with mass spectrometry (MS), a diode array detector (DAD) described by Markiewicz-Zukowska et al. (2013). 20 g of sample were mixed with 80 mL of 95% ethanol and then put on a shaker at 200 rpm and 37 °C for 24 h. The top layers were decanted and centrifuged at 3000 rpm for 30 min at 20°C. The total phenolic content was determined using the Folin–Ciocalteu method as described by Singleton et al. (1999), with some modifications. The total phenolic content was expressed as gallic acid equivalents (GAE) on a dry weight basis (mg GAE per g of solid), using a calibration curve obtained with gallic acid standards. Flavonoids were determined using the colorimetric assay described by Chang et al. (2002), with some modifications. The total flavonoid content was expressed as quercetin equivalents (QE), using a calibration curve obtained with standard solutions of quercetin. Antioxidant activity was evaluated using the DPPH and FRAP assays (Brand-Williams et al., 1995).



RESULTS

This study has conducted a comprehensive analysis of BBR, identifying key bioactive compounds such as polyphenols and flavonoids. The results of the analyses are presented in Table 1.

Table 1. TPC, TFC, and antioxidant capacity of BBR samples

Sample	TPC	TFC	Antioxidant Capacity	
			DPPH	FRAP
BBR	3.47±0.21	1.95±0.13	30.16±21.83	4.22±0.61

* The results are represented as mean as ± standard deviation (n=3).
* TPC results are expressed as mg gallic acid equivalent/ g sample
* TFC results are expressed as mg quercetin equivalent/ g sample
* DPPH results are expressed as % inhibition, and FRAP as µmol Trolox equivalent/ g sample.

CONCLUSIONS

When compared with the literature, the results of our study indicate that, although our samples being classified as BBR rather than pure beeswax, they demonstrated significant activity. These findings highlight the potential value of BBR, laying a foundation for further research on its applications in food and other sectors. The results suggest that BBR could be a valuable component. Based on this insight, it is planned that follow-up collaborations will be established to develop a more comprehensive project aimed at conducting an in-depth analysis of BBR's components, including hydrocarbons, free fatty acids, esters of fatty acids and fatty alcohol and diesters. This study aligns with the Action's sustainability goals by exploring innovative uses for agricultural by-products. BBR's potential as a sustainable ingredient may help reduce food waste and improve resource efficiency. Utilizing BBR in sustainable food products aligns with the Action's objectives and contributes to the broader goal of enhancing sustainability and competitiveness in the European food industry. Future studies will assess BBR's potential in mitigating the environmental impact of food production, contributing to both environmental and economic sustainability.

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